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University of Maryland at College Park

Center Office: IRIS Center, 2105 Morrill Hall, College Park, MD 20742
Telephone (301) 405-3110 • Fax (301) 405-3020

FREEDOM OF ASSOCIATION AND SELF-SELECTING GROUPS

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**Martin McGuire
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Author: Martin McGuire, University of Maryland at College Park

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FREEDOM OF ASSOCIATION, AND SELF-SELECTING GROUPS:

by

Martin C. McGuire*

The revolution in public economics embodied in the study of collective goods and the groups which provide them has produced essentially three paradigms of public good supply, the first due to Samuelson (1954), followed by Tiebout(1956)/Buchanan(1965) and then Olson (1965). Each of the latter generalized Samuelson along one dimension. Whereas Samuelson focused on coordinating coercive governments which provide pure public goods to groups of fixed size, Olson relaxed the assumption of coordination/coercion investigating the outcome if individual provision is voluntary, while Tiebout/Buchanan extended the analysis along the dimension of rival congested public goods and therefore of variable group size and composition. A useful way to summarize this taxonomy is with a table.

<u>Resource Allocation</u> <u>Within The Group</u>	<u>Group Size and Composition</u>	
	Exogenous	Endogenous
Coerced	Samuelson	Tiebout/Buchanan
Voluntary	Olson	Schelling/self-selecting

The table is suggestive of the fact that both a group's membership and its public good provision may be determined by voluntary action. Such groups are defined by their participating membership. I call this a "self-selecting group" or for reasons that will become clear a "Schelling Group". It completes the

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above matrix and corresponds to many informal social, business, and governmental groupings as well as more formal groups such as military alliances, international bodies and the like. In these cases, the group not only is not governed, it is not predetermined but rather emerges as an endogenous result of individual choices. Such associations are the subject of this paper. My thesis is that this paradigm has many counterparts in reality, has been largely overlooked in the literature, and has a cohesive analyzable logic.

In addition to the seminal work of Schelling (1972), the existing economics literature most directly related to self-selecting groups concerns the Nash-Cournot voluntary allocative behavior of individual members of a group of fixed and given size and composition. The individual and aggregate contributions of group members as a function of (a) the size of group, (b) the diversity of the membership, and (c) total group wealth and its distribution, have been examined by several authors, Andreoni (1988, 1990), Bergstrom, Blume, and Varian -- BBV -- (1986), Chamberlin (1974), McGuire (1974, 1990, 1991), McGuire and Groth (1985), and Warr (1982, 1983). In particular, how a group partitions itself into the two sub-sets of contributors and free riders is now well understood (Andreoni 1990, BBV 1986, McGuire 1991). This paper pursues that logic a step further by assuming that each individual's Nash-Cournot decision of whether to contribute or not also determines his membership status in the group -- in or out! The aggregate of such decisions will determine group membership.

II. Self-Selecting Groups

With voluntary Cournot provision of a public good, what determines the size and identity of group membership assuming free (possibly informal) association? This question has drawn less attention from economists than it deserves,

although there are obvious parallels to it in the tragedy of the commons (who over-exploits the commons) or analysis of congested public facilities to name but two. The only recognition of such groups I am aware of is contained in Schelling's (1972) analysis of multiperson prisoners dilemma.

Just as public good allocations are sometimes voluntary and uncoordinated, the size and composition of the group may be determined by voluntary association. In this case the issue of how group identity is established becomes one of what counts as participatory membership. The minimum possible definition and one proposed here is that an individual becomes a member of a group, provided he makes any positive contribution to its activities. Thus under such a definition, every one who contributes something and no one who contributes nothing counts as a member. That is, free riders are shut out of the group. If an individual wants to gain access to a group and to do so must contribute toward the group goal or good, how much will he contribute? My hypothesis is that he will make his Nash-Cournot contribution, since that is his best in the absence of his own strategy or group coordination. One individual's entry into the group may help or hurt existing members, but given that a new member has entered, his Cournot contribution will help those pre-established members of his group.

The principle governing the structure of self selecting groups therefore might be stated as follows: groups will grow by adding new members so long as anyone outside the group could benefit from entering and making his Nash-Cournot contribution to the common good; and pre-established group members will accommodate to this growth by adjustments in their Nash-Cournot contributions. The remainder of this paper explores the structure of groups which results from application of this principle. [An alternative principle might be to assume that established members of a group can exclude new entrants.

However this requires a degree of coordination among group members beyond that envisaged here].

Four generic types of cases will be investigated, corresponding to a 2-by-2 classification of (a) the distribution of individuals all identical, or heterogeneous in income/preferences, and (b) the nature of the public good whether pure and totally non rival, or congested and partially rival.

III. PURE PUBLIC GOODS GROUPS

Homogeneous Populations: All Inclusive, Population Wide, Nash Groups

We begin with the case of pure non rival public good consumption among a population of identical individuals. As established by the existing literature on Nash allocative outcomes, with the public good indeed truly pure, all consumers identical, and group membership treated as a parameter, as this membership size increases, the Nash-provision of the public good increases though falling further and further short of the optimal provision. This optimum itself races ahead of the Cournot limit at an increasing rate as group size increases. It is well known that each identical individual's Nash contribution to the public good in a group of size n , g_n^* tends toward zero as the group gets larger, and that the aggregate of all the homogeneous group members' contributions -- ie the total group provision, ng_n^* -- under Nash behavior tends toward that amount which if reached would drive the representative member to reduce his contribution to zero (Chamberlin 1974, BBV 1986, McGuire 1974).

For a group of n identical persons this situation is captured with the representative person's utility function shown generally in eq (1a) and with an especially easy Cobb-Douglas functional form in eq (1b).

$$(1a) \quad U = U[(w-g), (g + G_{-i})]$$

$$(1b) \quad U = (1-\gamma)\ln(w-g) + \gamma\ln(g + G_{-i})$$

where following the notation of BBV(1986) w indicates wealth, g the individual's public good contribution, the same for everyone at an implicit price of unity (so that private good consumption $y = w-g$), and G_{-i} gives everyone else's aggregate contribution. Necessary conditions for an individual optimum under Cournot behavior are given as

$$(2a) \quad -U_y + U_g = 0$$

$$(2b) \quad -[\gamma/(w-g)] + [(1-\gamma)/(g + G_{-i})] = 0$$

This outcome is compactly described in Fig.1 showing: (a) how to build up the reaction function, R_n , of n persons from that of $n-1$, ie R_{n-1} , and (b) then find the Nash outcome when the $(n+1)^{st}$ individual is added to the group. As pictured, when size of group increases parametrically, the Nash provision, designated as $ng_n^* = G_n^*$, progresses from g_1^0 when $n = 1$, (ie. the representative individual's "isolation purchase"), to G_{-1}^0 , which is the representative person's "free riding inducing" supply. These values are derived for the Cobb-Douglas case with n identical individuals as

$$(3) \quad -[(\gamma/(w-g_1^0))] + [(1-\gamma)/g_1^0] = 0; \quad \text{or} \quad g_1^0 = (1-\gamma)w$$

$$(4) \quad -[\gamma/w] + [(1-\gamma)/G_{-1}^0] = 0; \quad \text{or} \quad G_{-1}^0 = [(1-\gamma)w/\gamma]$$

$$(5) \quad -[\gamma/(w-g_n^*)] + [(1-\gamma)/(g_n^* + (n-1)g_n^*)] = 0; \\ \text{or} \quad G_n^* = ng_n^* = [(1-\gamma)nw/(1+\gamma(n-1))]$$

The utility of the representative person $U(y, G)$ under Cournot behavior and Cobb-Douglas utility therefore becomes

$$(6) \quad U = U[(\gamma nw / (1 + \gamma(n-1))) , ((1-\gamma)nw / (1 + \gamma(n-1)))]$$

to be compared with his utility when acting in isolation of

$$(7) \quad U = U[\gamma w , (1-\gamma)w]$$

Under the stated assumptions, clearly freedom of association produces a single group incorporating the entire population. For whatever the size of the group, its Nash provision G_n^* cannot exceed the representative individual's G_{-i}^0 , as is clear from comparison of eqs. (4) and (5). As n increases G_n^* approaches G_{-i}^0 from below. That is with all individuals identical the aggregate provision can never be so great as to induce zero contribution by any member. Therefore, every person outside the group -- outside by virtue of zero contribution -- will join by making his Nash contribution. Moreover, the individual's isolation utility shown in eq (7a) always falls short of his utility as a member of a group shown by eq (6a). The group, therefore, will grow until it includes everyone.

Heterogeneous Populations And Multi-Echelon Groups

A related paper which will be useful to this, (McGuire, 1991), extends procedures proposed by BBV (1986) to identify which are the free riders in a Cournot group of diverse individuals. That paper asks how to determine which members of a population of given size and composition will constitute the set of positive Nash contributors when everyone in the population whether a free rider or not enjoys the public good regardless. Subject to assumptions of non-inferiority of the public good and constant average cost of provision, the set of positive contributors (for any arbitrary distribution of diverse

utility functions and initial wealths among members of a group of given size) is determined by the cutoff free rider inducing supply, G_{-i}^0 . As defined above, this measure of the amount of public good necessary to induce an individual to cease contributing altogether is specific to each individual, depending on each's utility function and wealth, and the price of the public good. If individuals are ordered by their G_{-i}^0 from highest ($i = 1$) to lowest ($i = n$), then proceeding down the list the set of contributors will be closed once the aggregate Nash-Cournot supply, G_{i-1}^* , for $i-1$ and every one else above i (ie all those with greater G_{-i}^0 above i) exceeds G_{-i}^0 . No one with a free rider inducing supply below this cutoff will contribute anything to the group. This is an extension of the neutrality result first explicitly published by Warr (1982, 1983) and elaborated and formalized by BBV (1986), as well as Andreoni (1988, 1990).

In the above mentioned analyses the authors conclude that a public good group will contain some positive and other zero contributors. That may be the case in many groups where membership is fixed and given, but for self-selecting groups as conceived here, the cutoff contribution also determines cutoff membership. Thus all those above the cutoff G_{-i}^0 form a separate, self-contained group while those below will be excluded. Note, however, that those so excluded will then have an incentive to form their own group. Those excluded from the first group will not benefit from the public good provision within that group. They therefore may gain by forming a group "of their own."

Who will belong to this new group? Whoever makes a positive contribution! Who makes a positive contribution to this second echelon group? Whoever has a G_{-i}^0 higher than the cutoff for this second round of self selection! Third and subsequent rounds of self selection and their corresponding echelons of groups are easily imagined. Where does the process end? When the "isolation

purchase" of the last individual cut out of participation in the last group formed is zero. Thus the equilibrium will consist of groups of more or less homogeneous (with respect to their G_{-i}^0) individuals and a population of residual persons with no willingness to provide either for themselves or within a group. Figure 2 shows such a hierarchy of groups together with the cut-off membership and contribution for each echelon. The figure is drawn under the special assumption that everyone in the entire population has the same utility function, and differs from others only with respect to his income or wealth. The identification of group demarcations is greatly simplified under this assumption by the fact that within each group all income above the border-line income is necessarily allocated to public good provision. This feature of Nash-Cournot public good provision in populations with uniform identical utility functions was discovered by BBV (1986) and extended by Andreoni (1988). Thus, proceeding down the population from more to less affluent, once the aggregate of the excess of all individuals' incomes above the income of a particular individual provides just enough public good to induce that individual to refrain from contributing at all the membership of that self selecting group is closed. This is the outcome pictured in Fig 2. For a general method of identifying group membership without the simplification of identical utility functions see McGuire (1991).

This structure is similar to Thomas Schelling's (1972) analysis of multi person prisoner's dilemma. In that paper Schelling asked how many individuals, k , in a larger group of n , must cooperate by choosing the dominated strategy to benefit themselves irrespective of the actions of the other $n-k$. This he called a "minimum viable coalition." He also raised the possibility of "successive coalitions" where from the $n-k_1$ remaining after one coalition has formed, a second coalition of k_2 might form, and so on. Although structurally

similar there is an important difference between the context of Schelling's analysis and this. In Schelling's model individuals deliberately cooperate rejecting the dominated strategy. In this model no one actually cooperates; everyone follows his myopic self interest; successive associations (not really coalitions) arise without anyone intending or sustaining them.

To summarize the case of pure non-rival public goods, individuals will freely associate into self selecting groups, as elaborated above, according to their willingness to contribute. Notably, in a population of identical persons -- with the utility functions, wealth endowments, isolation purchases g_i^0 , and free rider inducing supplies G_{-i}^0 the same for all -- only one group will form. In contrast, a population of diverse individuals could produce several echelons of free association plus a tail or residual of non-participant/contributors. In a diverse population, restrictions on free-riding therefore are doubly wasteful, since these force those excluded to form "their own" groups which is a pure resource waste.

IV SELF-SELECTING GROUP FORMATION UNDER CONGESTION

The foregoing argument indicates that diversity among individuals, their wealth and/or preferences, is required to establish multiple and diverse (although resource wasting) public good associations if the public good is ideally pure. The pure non-rival assumption, however, is extreme and might be assumed to produce extreme conclusions. By contrast, impure rival public goods which arise from congestion in consumption or dilution of spillovers as group size increases can require multiple and diverse groups for allocative efficiency along the lines of club theory. But does such non-rivalry lead to multiple groups in a Nash-Cournot self-selecting equilibrium?

Various factors in the nature of "impurity" of a public good might be adduced to explain the emergence of more than one self-selecting group for the provision of the same public good. The most common in the literature and the one considered here will be congestion leading to average cost increases for the provision of the public good to increasing numbers. Possibly the simplest form for representing congestion is to assume the unit price of the public good "p" depends on the number of individuals in the group $p=p(n)$, (with $p' > 0$, $p'' > 0$ throughout) irrespective of their individual characteristics. For instance $p(n)$ might represent administrative costs in a charitable organization which increase with membership.

Congested Public Good and Homogeneous Population:

With identical individuals, incomes, and preferences representative utility becomes

$$(8a) \quad U = U[(w - p(n)g), (g + \overline{(n-1)g})]$$

with the Cobb-Douglas version as

$$(8b) \quad U = \gamma \ln[w - p(n)g] + (1-\gamma) \ln[g + \overline{(n-1)g}]$$

Necessary conditions for a first best maximum are :

$$(a) \quad nMRS_{gw} = p$$

ie the Samuelson condition where p = marginal (average) cost (n fixed) and

$$(b) \quad p' = p(n)/n$$

which is the efficient sizing condition, such that p/n is minimized. This is the configuration an enlightened government internalizing all public good spillovers should strive to implement. How does it compare with the outcome under voluntary association?

In the formation of self-selecting groups both the contributions to provision of the public good and the decision whether to join a group at all are made in an uncoordinated, voluntary fashion? Application of the first, ie the voluntary contribution principle under congestion is straight forward, no different than with non-rival public goods. The lack of coordination in allocative decisions is indicated in eqs (8a and 8b) by the bar over $(n-1)g$; each individual under Nash behavior ignores this provision of public good by the $n-1$ other identical participants when he decides to contribute.

With respect to membership decisions, our underlying principle of free association states that: groups will grow by adding new members so long as anyone outside the group could benefit from entering and making his Nash-Cournot contribution to the common good; and pre-established group members will accommodate to this growth by adjustments in their Nash-Cournot contributions. Thus, we assume that existing groups formed by free association cannot limit their numbers in their own self interest; instead that unimpeded free entry into any group is permitted even if existing members lose, provided only that newcomers make some positive allocative contribution to the group?

A capacity among existing members to restrict participatory membership in their own self interest against willing contributors implies a degree of group governance beyond that of a self-selected group as envisaged here. However, we will assume as with non-rival public goods that a self-selecting group can enforce total exclusion of the public good from those who decline to make a contribution. This implies: (a) that potential participants will join a

free association, and make their Cournot contribution as long as such a decision benefits them and, (b) that the resulting self-selecting group will continue to grow in size until the marginal participant finds that remaining out of the group and providing himself with his "isolation purchase" of the public good is no better nor worse than participation in the over-crowded, under-providing voluntary association. It will become apparent that provided there are sufficient individuals in the overall population such that integer or lumpiness problems can be neglected, and provided all individuals are identical, participation by one member will not drive another out of his self-selecting group. It will also become apparent that such difficulty can arise once diversity of individuals is admitted.

Straight forward deductive analysis of the uniform population case is facilitated by our knowledge that for any value of p , the aggregate Cournot provision of n identical people, ie $ng_n^* = G_n^*$, increases as n increases and for that value of p approaches an asymptotic limit of g_i^0/γ , where g_i^0 or g_1 represents the individual's isolation purchase and depends on the (constant average) price of the public good $p(n)$, $(1-\gamma)$ represents the marginal propensity to spend on g , and γ and g_i^0 are the same for all i . (see McGuire 1974, Chamberlin 1974, or Cornes and Sandler 1984)

This implies that the Cournot provision ng_n^* either falls for all $n > 1$ or that it rises at first and then falls, as shown. In either case, with $p' > 0$ throughout and G a normal good, the individual provision g_n^* falls monotonically with increases in n at a faster rate than if $p(n)$ were a constant. The combined effect of these two factors as n increases can be readily analyzed with a diagram as in Fig 3. There the individual's isolation purchase and associated utility is shown as the tangency of U^0 with the price line $p(1)$. As n increases the individual's resource contribution $pg(n)$ declines so that

the consumption point moves upward, while the quantity of the public good consumed, ie ng_n^* first increases and then finally decreases. The combined effect yields the individual's consumption opportunity set as a function of n , designated as $C(n)$. We know from the results of Warr (1983) and BBV (1986) that $C(n)$ is the same for all positive contributors in the group -- ie all members of the group under our assumptions. Also shown in the picture, for reference is $[p/n]_{\min}$ and the associated maximal utility which a truly optimal club would provide. The best feasible self-selecting group clearly cannot achieve this outcome since it is restricted to the consumption opportunity set $C(n)$. Clearly then a second best "optimal" self serving voluntary association would require that entry be limited in the interests of the existing membership as shown as at point a, whereas equilibrium formation of free associations according to our meaning is as shown at b. Identical people crowd into these until their welfare is no higher than if they provide the "public" service all by themselves. The interesting implication is that congestion effects will actually limit the size of the self-selecting group even in a population of identical individuals. The group size is limited not to the second best "optimal" group size (point a) but at least short of the entire population as in the pure non-rival public good outcome. Since individuals of a type will crowd into a group only until the utility of the representative group member falls to that of those remaining outside (ie U falls to $U[\{g(w, p(1)), (w - p(1))g(w, p(1))\}]$), more than one free association may form even in a uniform population. As pictured in Fig 3, in each homogeneous self-selecting group the aggregate "equilibrium" provision G_n^* falls short of any individual's free riding inducing supply, $G_{-i}^0[p(n^*)]$. (Use of the term "equilibrium" is subject to a caveat since we have not postulated a mechanism to create new groups and sustain them at their voluntary optimum as at point a.)

For a homogeneous uniform population with identical Cobb-Douglas utility, the individual Cournot provision, free riding inducing supply, and Nash group provision under congestion are summarized by eqs (9), (10), and (11).

$$(9) \quad g_n^* = (1-\gamma)w/[p(n)(1 + \gamma(n-1))] : p(n)g_n^* = (1-\gamma)w/(1+\gamma(n-1))$$

$$(10) \quad G_n^* = n(1-\gamma)w/[p(n)(1 + \gamma(n-1))]$$

$$(11) \quad G_{-i}^0 = (1-\gamma)w/[p(n)\gamma]$$

Comparison of eqs (10) and (11), confirms that indeed increasing numbers of identical persons will never provide so much G_n^* as to exceed the free rider inducing amount G_{-i}^0 -- that is for all n , $G_n^* < G_{-i}^0$. Accordingly, such self selecting groups will grow in membership just as in the pure public good case, but only until a critical value of n and therefore of G_n^* is reached. Once this point is reached, all others in the homogeneous population will refrain from joining and instead will evolve another group. In summary, in the homogeneous population case, the effects of congestion -- increasing average cost of provision with increasing numbers in freely associating groups -- causes participatory membership to be closed off voluntarily by the rising inefficiency of voluntary collective action. At the margin of membership newcomers refrain from entry not because as unwelcome free riders their entry is blocked (as in the uncongested case) but instead because the costs of collective participation make isolated private provision preferable. In a homogeneous population those remaining in the congested group and making their voluntary contribution are similarly just at the margin of indifference between voluntary collective and individual private provision. In short, the congestion itself rather than free riding limits voluntary group size.

Heterogeneous Population:

An implication of the above analysis is that a homogeneous population will settle into a stable set of congested voluntary groups. This changes dramatically once diversity in the underlying population is introduced. To demonstrate the implications of non-uniformity, I will continue with the assumption that everyone's preference function is the same, that people differ only in income or wealth. We know from others (Warr, BBV etc) that if all members of a voluntary group are positive contributors, all enjoy the same net private and public good consumption. Thus the consumption opportunity set is the same for all positive contributors to the group. As the size of group increases, the consumption point of each and every group member moves along the same curve $C(n)$, while the endowed initial wealth point of newcomers moves down the y-axis as the membership margin extends to less affluent individuals.

As in Fig 4 there are three possible membership margin configurations under congestion of the type treated here (same full price for all members and anonymous crowding). The isolation budget constraint of the most affluent B_1 and of increasingly less affluent $B_2, B_3 \dots B_i$ etc. is shown by the family of budget lines. There is a group consumption opportunity set $C(n_i)$ as individuals join the group beginning with "1" the most affluent and proceeding in order of affluence to "i." Evidently $C(n_i)$ depends on the particular distribution of B_i . As each individual newcomer joins the self-selecting group and makes his Cournot contribution the price of g increases. This of course influences the Cournot contributions of all other existing members of the contributing set.

The composition and stability of the membership of a self-selecting group depends on the rate at which lower and lower budget individuals are

added to the group as $C(n_i)$ approaches U_1^0 , the isolation utility of the richest individual. First, the distribution of B_i can be such that the last positive contributor to the richest self selecting group just drives the first (most affluent member) to the point of indifference between staying in the group and retreating to isolation. We denote this last or least affluent member of the first group as "Mr." $k(1)$. All individuals with budget lines below $B_{k(1)}$ would not make any voluntary contribution to this group (group number 1). Each of these k individuals would, of course, most prefer to join and ride free. But because this would raise the unit cost of public good provision, $p(n)$, it would drive existing members out of the group starting with the richest, and in any case it would violate our axiom that free riders are excluded. Thus in this case the top-most affluent person of the group desires to remain in it, and the "bottom-least" affluent person is just admitted and everyone in the group consumes at point k_1 . Individuals less affluent than $k(1)$ are of course free to form their own self-selecting group a la Schelling.

Fig 4 might show a different configuration. If the density of individuals over the endowment range B_1 (at the top) and $B_{h(1)}$ (at the bottom) is so thin that before the most affluent member is driven to indifference between group participation and isolated provision, membership is closed because of the no free rider axiom. In this case Fig 4 shows all group members consume at point h_1 . Other lower echelons of groups may form -- Schelling Groups -- beginning with those with endowed incomes below $B_{k(1)}$ and these may be stable or unstable.

Fig 4 also shows the last of three possible configurations. In this case the density of individuals with endowed incomes near to B_1 (the top) is relatively tight. Now consider adding members to a self-selecting group proceeding from the top. With a high density of individuals, so many voluntary Cournot con-

tributors may gain entry into the group that they drive the most affluent below their isolation utility. Once individual j with endowment $B_{j(1)}$ is reached, further additions to the group will push the top individual, "1" [with B_1] out of the group. Still j and many below j will benefit from joining a group composed of Mr. "2" as the richest. But now "2" will desert the original group, preferring to join "1". Obviously the process is unstable, and may cascade down the entire distribution.

V CONCLUSION

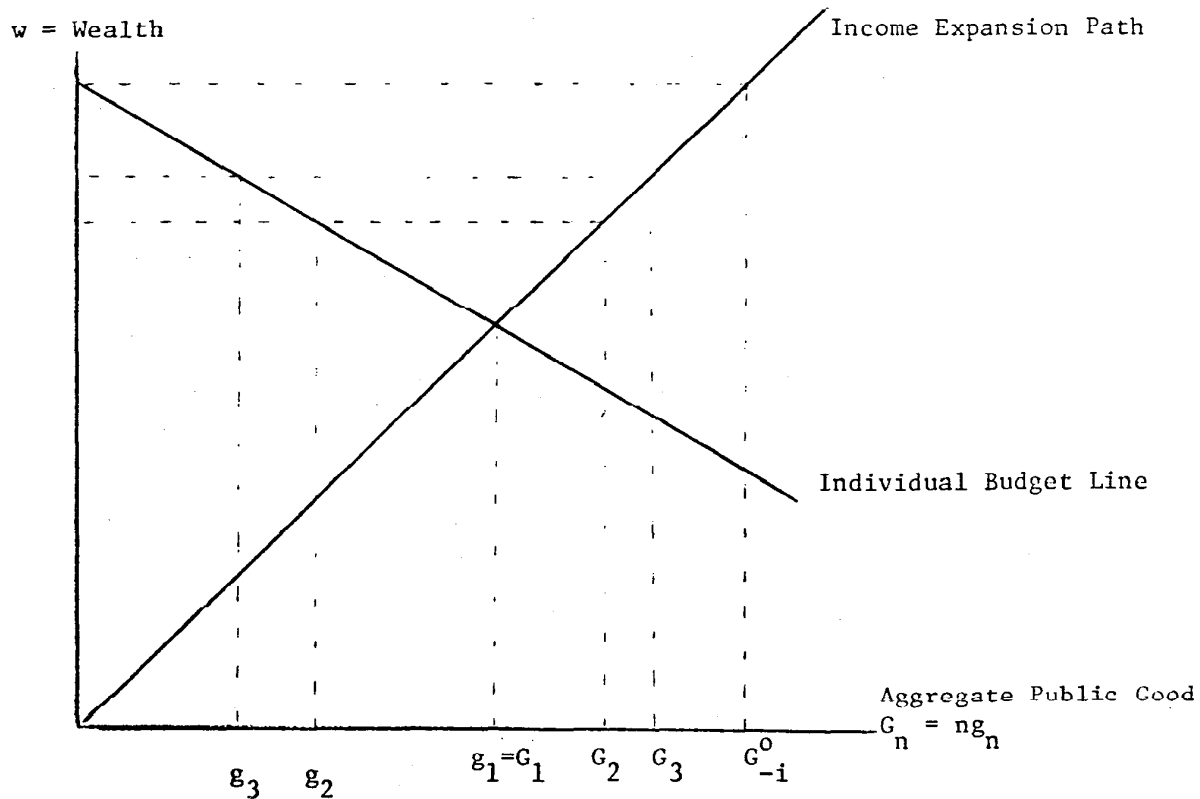
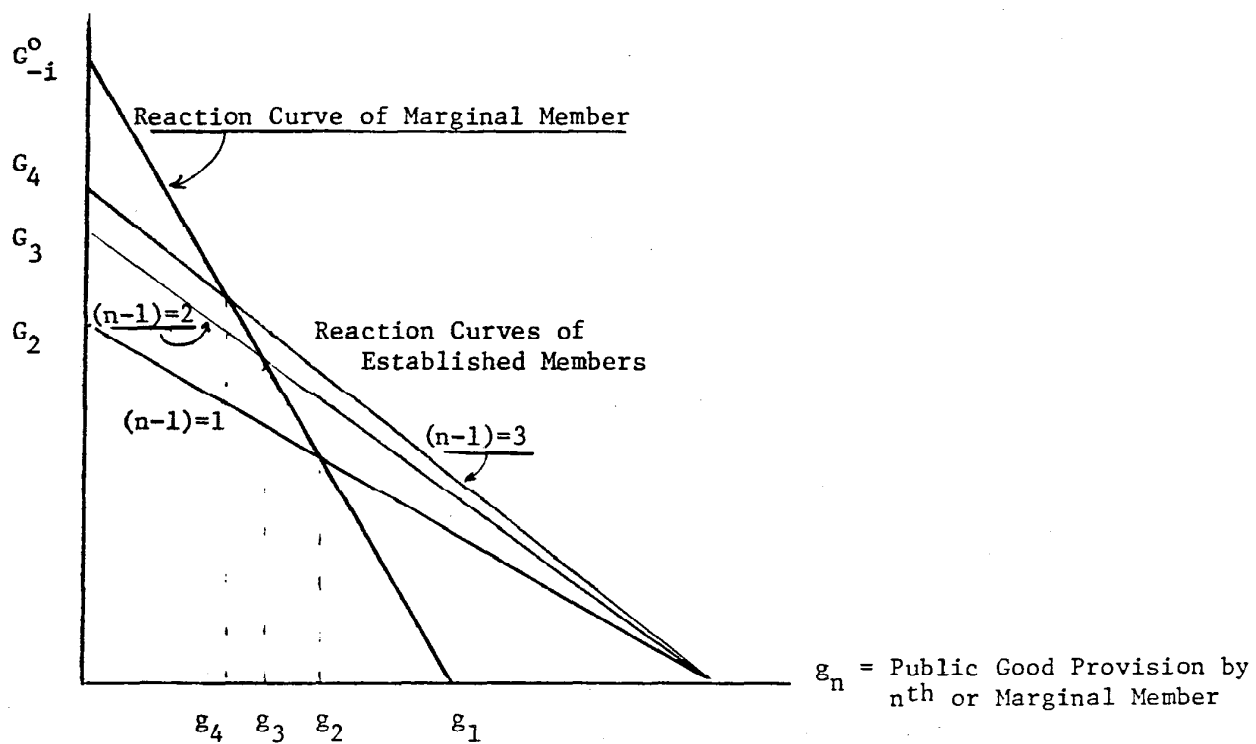
This paper has built on the idea of the neutrality of public good provision within a group of fixed size to redistributions of income among those Nash-contributing members of the group. The proposed extension of the standard model has been to assume that only voluntary Nash-Cournot contributors are admitted to self-selecting public good groups. Following through on the logic of this assumption implies that populations may partition themselves into non-overlapping groups made up of individuals with similar "free rider inducing supplies" of the public good in question. If the public good is pure and non-rival, the population will form a stable set of groups and a residual or tail of unaffiliated individuals. If the public good in question is subject to congestion, similar configurations are possible, although problems of stability may arise depending on the effects of crowding on costs and on the distribution of incomes among individuals.

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$(n-1)g_n =$
 Public Good Provision by
 $(n-1)$ Established Members

FIGURE 1



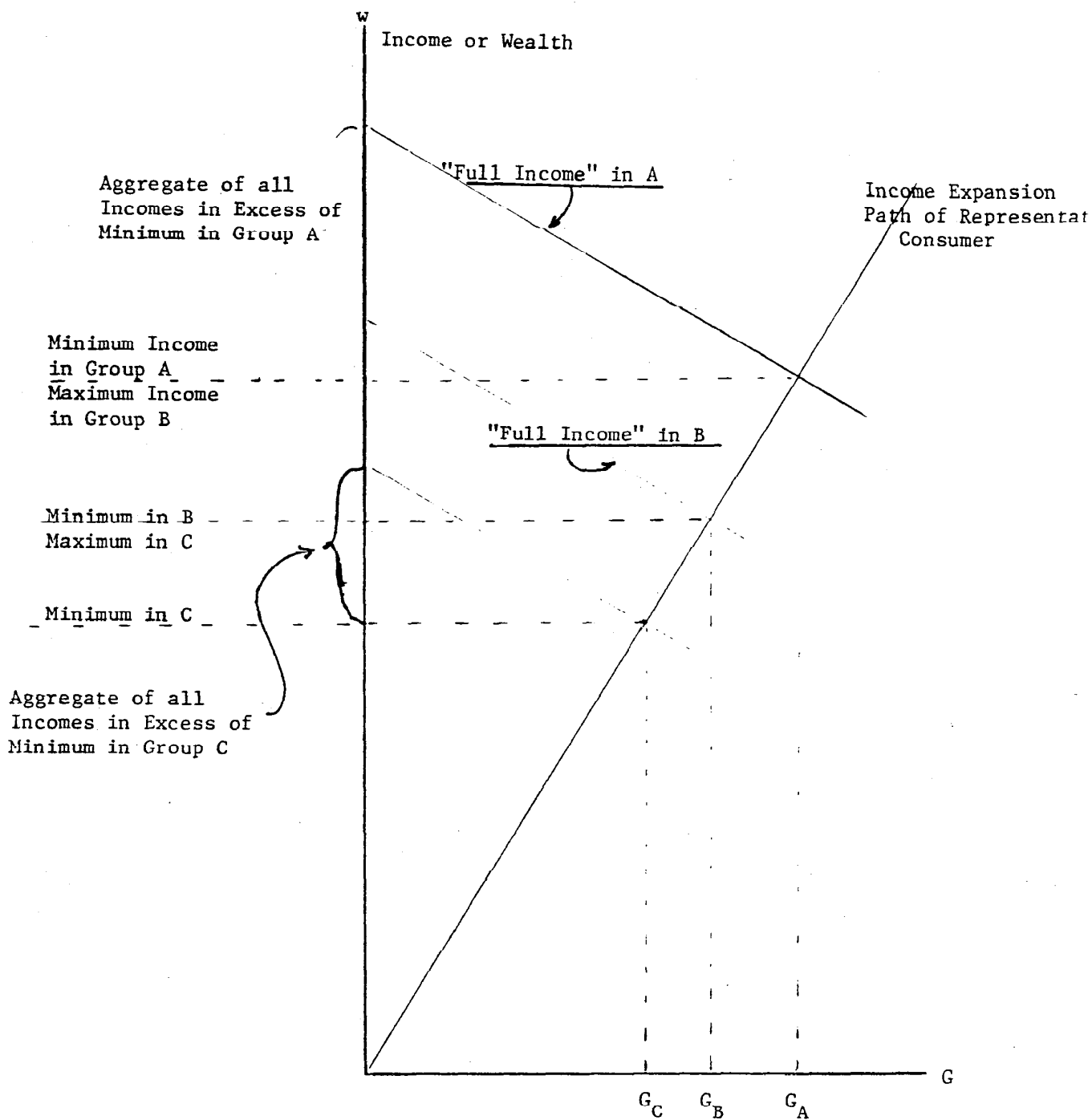


Figure 2

Self Selecting Groups for Provision of
a Pure Public Good to Heterogeneous Populations

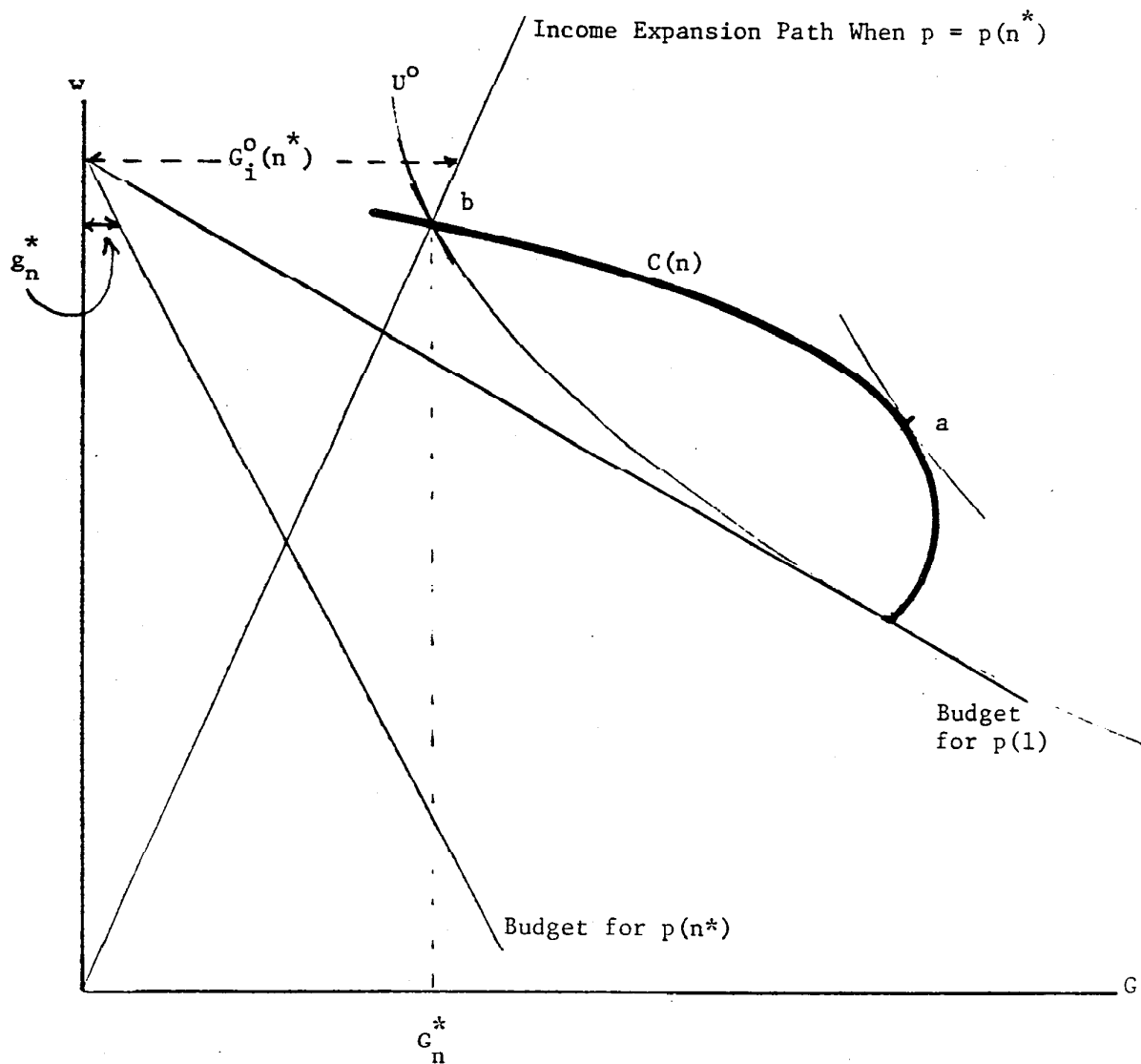


Figure 3

Self-Selecting Cournot Group of Identical Individuals
Subject to Congestion

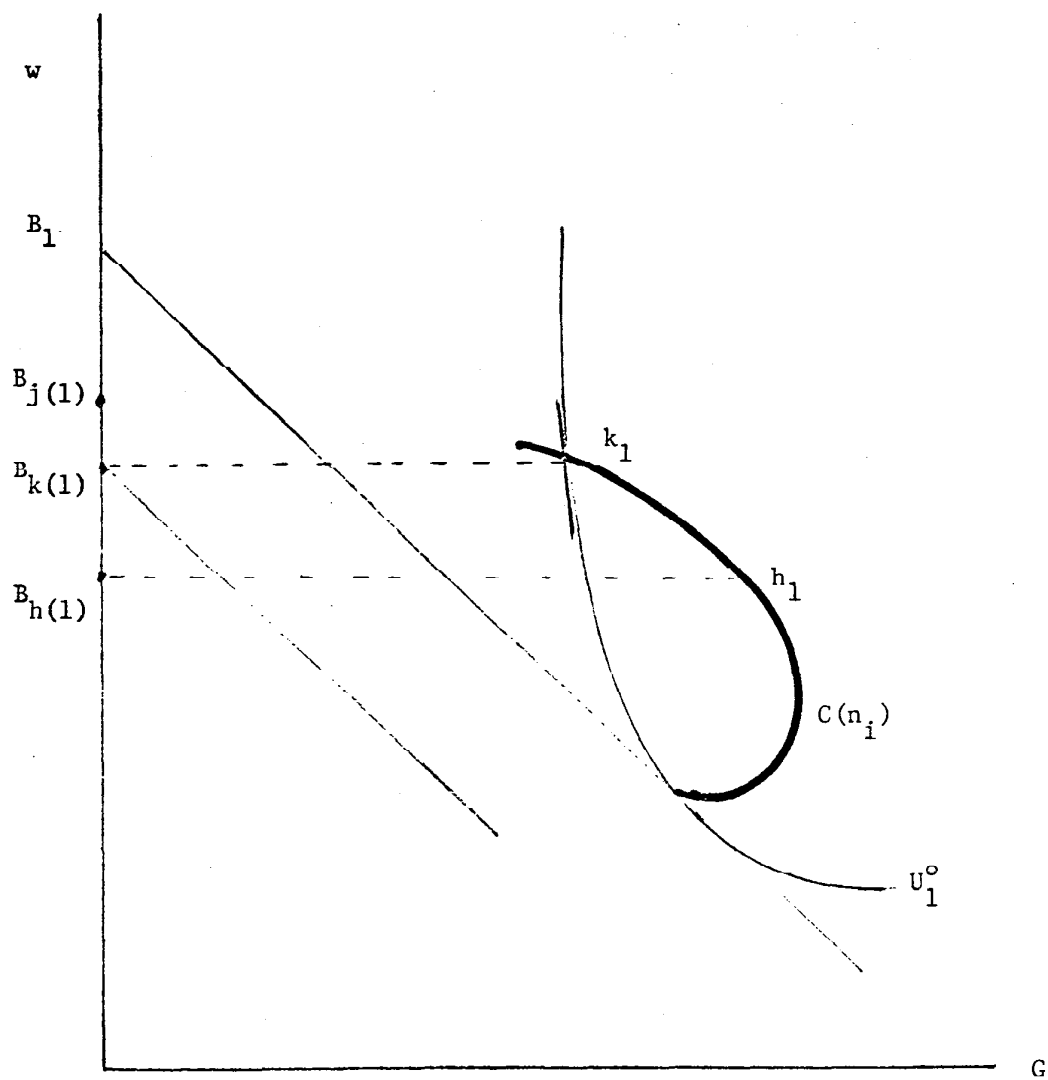


Figure 4

Alternative Self-Selecting Groups of Congested
Heterogeneous Populations